Fireball and meteor event 20130824190218UTC'Pilis'

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Introduction: The medium sized fireball events are hardly (or mostly non) documented analytically. The small meteor events, for example meteor showers are caused by sand sized grains and almost all of them disintegrate and never reach the Earth's surface. However, they are observed on thy sky as paths radiating when they entry to the higher atmosphere. They can be observed and analyzed chemically from spectrograms of pictures and videos of meteor surveillance cameras and have a large documented data. Large meteor events with greater abundance of fallen meteorites are well documented from physical and chemical analyses of pieces. **'Medium'** sized meteor events are not well documented because they overwhelm and overflow the usual meteor shower surveillance cameras and it is hard to find any pieces from falling, because of small amount of fallen mass. Let we try to document a new event.

Our earlier works documented the falling camera images which were used to identify the touchdown region of the meteorites. Especially, in the case of the Kosice meteorite fireball and falling event, all steps from webcam pictures of fireball throughout collection at the falling site and the petrologic analysis of the pieces have been documented in this way. (2011)[1]

The Pilis Event on 24th August, 2013: There was a fireball event above Slovakia and Hungary on 2013.08.24. 21:02 UT. We have collected web camera sources from the internet, nine photographs and one video record and some well documented descriptions from witnesses, like Molnar. Images were taken by eight web cameras, two of them were ski webcams of ski-truck at slopes, one was a meteorological webcam and others were panoramic webcams. The video is a record of a car dashboard camera. The place was near to Radom, Poland, but only approximately known. The image sources were Cerna Hora, Nadejkov, Medvedin, Ondrejov, Paprsek, Stitna nad Vlari, Temelin, Vsetin (Slovakia). [2] In Hungary the sky was covered by clouds, so only the strong lightning of the final explosion was observed for example at Dorog, or Pilisszentlélek, both in Hungary. One well documented witness wrote she heard a serial of sonic booms, the first sound come 160-170 seconds after the last light at Perbal, Hungary. Several significant information were collected by Biro, Molnar and Tepliczky. [3]

Early, quick processing conception by Vizi (2011)[1] was carried out in order to select at least two well computable webcam pictures which are relatively long distance observations from each other both in km-s and in angle of view. Google Earth and other maps were used to calculate the positions. GPS positions of cameras were identified first, which was a bigger task for several hours. Finally Medvedin and Temelin were selected for first quick computing.

Picture Processing: Cerna Hora: Černá Hora, Czech Republic, Europe, 'Zinneckerovy boudy' ski house, 1095 m, 50.644073°N 15.762633°E, Camera direction: azimut:132,5° ±1° declination: -3° ±1° below of the horizon.

http://kamery.humlnet.cz/archiv.php?kamera=cerna_hora&datum=1377371040&velikost=2048

Medvedin: Medvědín, Krausovy Boudy, Královéhradecký kraj, Czech Republic, Europe; ski house, 1231m 50.741430°N 15.580742°E, Camera direction: azimuth: 115,5 ° ±1° declination: -2,765° ±1° below of the horizon, (came from arc tan of perpendicular leg from height: 1231-990m and from distance leg: 5000m of measurable triangle from height data of Google Earth) .Start of fireball 149,92°, end of fireball 145,25°, orbit line at horizon 142,6° azimuth

Significant surface objects were available to pinpoint the vertical planes of begin and end of fireball and stab point of orbit.

Temelin: Temelin Webcam of Meteorological Tower, Czech Republic, Europe, webcam: 535m, 49.197937°N 14.342840°E

End of fireball 115,19° azimuth, orbit line at horizon 114,52° azimuth. The early begin of fireball is missing in Temelin, because of the local start of the exposition, but from other full long fireball orbits it was usable especially to pinpoint the end of fireball and the end of the orbit. Other cameras were processed later by Hegedus and Csizmadia, see below.

Video processing can be used to determine the start, orbit and the end of the fireball light, the brightness (from the known distance), the timing of the event (frame by frame) and form this info the estimated time of the fireball (Vizi). The only available info was: car video was taken near the town Radom, Poland. The correct position of camera was calculated from direction of fireball, the angle of the turn of the road and from several available objects, like the settlement early warning traffic sign table and reflective lane guide plastic bollards of road, concrete fence and it's corner on left side, lamps of lighting poles. The searching was successful on Google Earth and Streetview.
The position of the video camera: 51.258840°N 21.095921°E, azimuth. 21 frames, 7frames/s, fireball 3s.

The quick approx results (Vizi)**:** Init: 100kg, speed Solar 14km/s, at atm. 20km/s fall 47.67°N 18.96°E fall 1-5 kg.

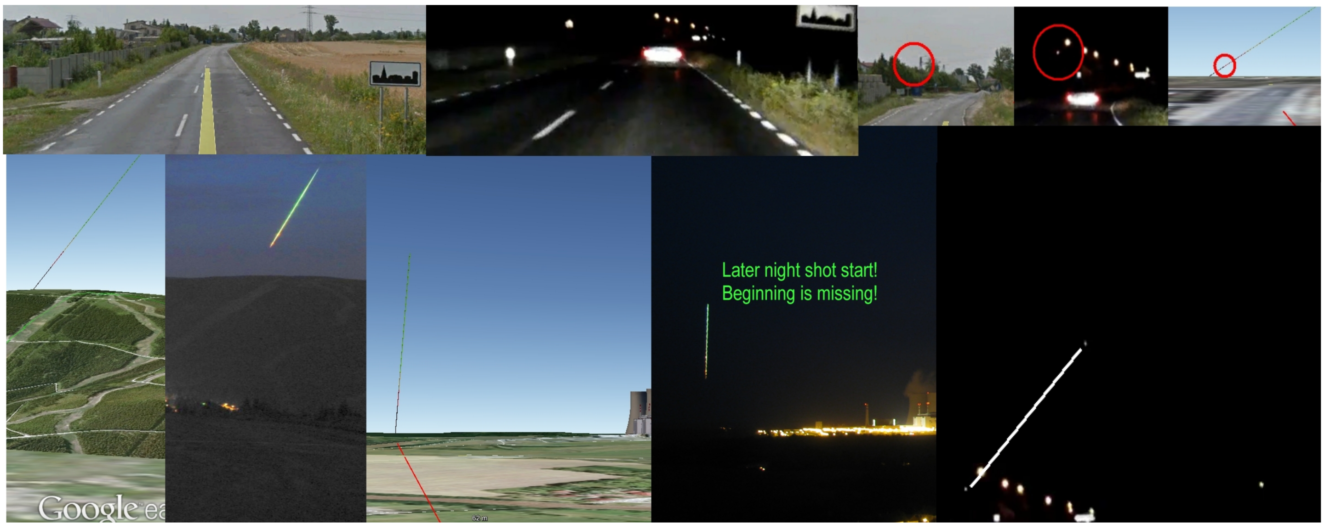

Figure 1. Comparison of pictures of Medvedin, Cz. Temelin and Radom, Pl. simulated model, original photos, StreetView and video

Numerical Processing:

Table 1. Averaged results of three atmospheric path calculations – using each possible dublett combinations of the photos of Czech cameras (Crna Hora. Paprsek and Temelin. Cz) (Hegedus)

First common point *			Last common point *			Rectilinear section		Real radiant		av'g spe.	initial mass*
latitude	longitude	h (km)	latitude	longitude	h (km)	latitude	longitude	RA (h)	Dec (deg)	km/sec	kilogram
47.8166	18.3872	57.39	47.6542	18.7537	29.19	47.4873	19.1318	13.3239	49.2569	11.79	431
±0.32	±0.18	±1.7	±0.10	±0.05	±1.7	±0.24	±0.14	±0.82	±9.93	±5.8	±411
±23.5 km	±20 km		±7.5 km	±5 km		±18.5 km	±15.5 km				

Table 2 The atmospheric path calculations – using all photos of the three stations (Crna Hora. Paprsek and Temelin. Cz)

First common point *			Last common point *			Rectilinear section		Real radiant		av'g spe.	initial mass*
latitude	longitude	h (km)	latitude	longitude	h (km)	latitude	longitude	RA (h)	Dec (deg)	km/sec	kilogram
47.8172	18.4073	54.4	47.6550	18.7530	29.2	47.4633	19.1561	13.0021	49.6073	11.6	425
±0.13	±0.10	±4.1	±0.13	±0.10	±2.8	±0.35	±0.31	±2.25	±16.84	±2.8	±301
±10 km	±11 km		±10 km	±11 km		±26.5 km	±34 km				

* These points are not connected with the first visual or photographical appearance of the fireball. but the first and last common points. which has been possible to use in the calculations. The calculations were done by the more developed version of the original 'SZIMFEL' code. The theoretical background of this software is developed and described by T. Hegedus (1986). The errors are estimated by a Monte Carlo simulation (added artificially a 30" random errors into all observed input data).

Table 3. Calculations from available cameras (Csizmadia Sz., priv. comm.)[4]

1st camera	2nd camera	Begin (km)	End (km)	Begin (N, °)	Begin (E, °)	End (°, N)	End (E, °)	V (km/s)	Radiant (RA)	Radiant (D)	Q(AB) [°]
Cernahora	Paprsek	54,7	25	48,0922	18,1942	47,8841	18,6062	14,75	207,01	49,32	11,02
Medvedin	Paprsek	56,9	26,1	48,0334	18,2277	47,8017	18,6606	16,14	188	51,33	11,63
KNM	Paprsek	59,7	30,3	48,2188	18,178	48,0199	18,5406	14,37	208,86	49,01	39,4
KNM	Medvedin	62,4	32,6	48,1695	18,1612	47,9512	18,539	14,78	200,9	52,47	50,53
Cernahora	Medvedin	72,8	53,9	47,3836	18,8159	46,0416	20,3107	44,79	319,69	-32,36	0,75
Cernahora	KNM	60,1	32,2	48,187	18,1685	47,9754	18,5434	14,28	208,49	49,21	49,18
Paprsek	Temelin	59,3	29	47,813	18,376	47,673	18,743	15,45	206,88	49,22	40,22
Medvedin	Temelin	60,6	30,04	47,77	18,494	47,645	18,814	14,21	212,34	50,83	29,18
Cerna Hora	Temelin	60,2	30,5	47,762	18,514	47,633	18,848	14,33	207,09	49,3	29,77
KNM	Temelin	66	37,49	47,928	181,79	47,772	18,528	14,77	207,85	49,52	75,86
Weighted average		62,0 ±1,5	32,7 ±1,0	48,0129 ±0,051	18,243 ±0,048	47,837 ±0,068	18,604 ±0.075	14,7 ±1,0	206,8 ±3,0	49,97 ±2,4	Weight: sin^2 Q

Initial mass range:12-230kg, probable 49kg. Absolute brightness is -8.5 +/- 1.5 mag. Min terminate mass is 0,51 kg. Fall: 47°37' 10" = Uncertainty: 5' 57" and 19°01' 28" Uncertainty: 5' 28"; in decimal the fall is: **47.617915°N 19.025647°E**

Speed of Meteor: According to our calculations the atmosphere contact speed was 14,5 +/- 2,5 km/s

Orbit of the Pilis Meteor in the Solar System: According to the plane of orbit and the acceleration effect of Earth's gravitation the Pilis meteor came on an orbit from the inner part of Solar System approaching the near vicinity of the Sun.

Analytical: Can we estimate any analytical information from available pictures until we haven't fallen pieces? Considerations: If light is generated by thermal process then colors are 10000K cyan, 6000K white, 5000K yellow, 4000K orange and 2500K red, which would also be assigned to the following emission centers in the electromagnetic spectrum. A wavelength range between 400 and 500 nm (blue region) is associated with Fe, dominantly. This region also contains Ca (at 398, 423 and 448 nm). The spectral area ranged between 580 and 630 nm is related to Na, respectively. Absence of the olivine-induced green color (due to the chondritic material) may also indicate the cometary formation of the Pilis meteorite (Refs), however, its origin is still a matter of further discussion. Then now let we look at the fireball picture made by a Canon EOS 1100D used by webcam network. The camera is optimized to make pictures for human vision electronically on a computer.

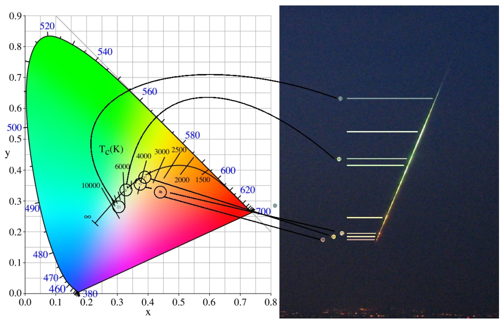

Figure 2. Compliance of the Planckian black body locus and the best photo.

We are continuously searching for new data and meteorite pieces of this fireball-meteor event and at fall place we are in connection with local restaurants, post offices and mayors.

Conclusion: Last few meteor events and the new detection possibilities implied: it is necessary to collect an updated global data, to collect freely the observations of the available cameras and its positions. In addition it seems to be necessary to investigate the building up a network - which is a combined surveillance system both for small and bigger meteor events, - with meteor cameras to record and analyze time and timing, orbit and direction, spectrum of fireball and the falling position.

References:

[1] Vizi et al., (2011) Summarized Analysis and Conclusion of Fireball-Meteorite "2010.02.28. Košice" nipr symposium2012/ E31_M_PalVizi_1.pdf. [2] Hulmnet, Cz. kamery.humlnet.cz, kamery.humlnet.cz/archiv.php?kamera=cerna_hora&datum=1377371040& velikost=2048 [3] Biro et al.: Fireball blog, http://tuzgomb.blogspot.hu/2013/08/fenyes-tuzgomb.html [4] Csizmadia Sz., priv. comm.)